Public Preference for Data Privacy– A Pan-European Study on Metro/Train Surveillance

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ABSTRACT

This paper presents a pan-European application of a stated preference dicrete choice experiment for eliciting respondents' preferences for various data-privacy settings in the context of security and surveillance of train/metro facilities in Europe. Results show that respondents across the 27 European Union Member States (EU27) prefer some Closed Circuit Television Cameras (CCTV) surveillance across in all countries, except Sweden where the most advanced type of CCTV with face recognition capabilities is preferred. Most respondents prefer that CCTV data is stored for future use rather than just being used for real-time monitoring, with the exception of respondents in Greece. However, an intermediate period of storage (15 days) is preferred over a shorter or longer duration (45 days). Respondents across the EU27 are averse to police force outside their home country having access to CCTV data. Respondents prefer the presence of unarmed security personnel over absence of security personnel. The majority of respondents are averse to any kind of security checks. However, in Belgium, France, Italy, Spain and the UK there is a preference for randomly selected people to go through a metal detector or full body scanner. Further this study shows that preferences also vary by age and gender. Overall, analysis of the data illustrates the complexity of the privacy over security debate as it pertains to transportation infrastructures. In particular, the increased use of transportation user data for various reasons (efficiency, safety and security) can pose complex social and ethical challenges to users, especially around perceptions of consent, accountability and transparency.

Keywords: Data privacy, Surveillance, CCTV, Security, Train, Metro

INTRODUCTION

Railway and metro infrastructure are subject to a variety of types of criminal behahviour such as robbery, abuse and anti-social behaviour. In the last decade, these infrastructures have also become popular targets for terrorist attacks with deadly consequences. In the case of the latter, these have taken place at stations or on-board buses and trains at major capitals including Brussels (22/03/2016), London (7/7/2005), Madrid (11/03/2004), Moscow (29/03/2010), Paris (25/06, 17/08, 26/08 1995), and many other cities across the globe (Global Terrorism Database, 2016). These incidents have shown that public transport systems are vulnerable and given the volume of travellers using them do remain a likely target for future terrorist attacks.

As a consequence, there has been a shift in European security-policy towards – as stated by the European Commission President Jean-Claude Juncker, a 'common European Responsibility' (Friesen, 2007; European Commission, 2016). For example, the Internal Security Strategy 2010-2014, the European Agenda on Security and the Treaty of Lisbon provide the policy and legal frameworks 'aiming at achieving liberty and security' in the European Union (European Commission, 2015).

Practically, responses to the aforementioned terrorist attacks have also brought forward the deployment of a wide range of security measures and surveillance technologies in an attempt to mitigate the risk of incidents re-occurring and address the consequences should they occur. In many European countries and beyond, surveillance involving video or camera technology – what is widely known as Closed Circuit Television Cameras – is now a standard feature at stations and on board buses and carriages. For example, the London Underground has now more than 15,000 CCTVs with a default footage-retention period of 14 days (TfL, 2016). Development of advanced CCTV-based surveillance technologies also means these systems are now capable of incorporating automated algorithms for the detection of dangerous conditions; for example, whether an individual carries a knife or firearms (Grega et al., 2016). New surveillance technologies are also capable of tracking behaviour and detect suspicious movements or certain patterns of clothing or baggage (Sahm, 2006).

Other measures include deployment of additional number and of varying specialism security personnel including armed police and the military. Following the Brussels attacks in spring 2016, armed police were deployed to airports, train stations and other urban infrastructure where large numbers of people congregate in Europe. For example, France deployed an extra 1,600 police officers to transport hubs across the country with the majority of them based at Paris (The Local, 2016). In many cases, security personnel were accompanied with sniffer dogs and extensive checks were also implemented.

While such measures are aimed at providing increased levels of reassurance to the general public, they may compete with citizens' privacy, civil liberties and dignity (e.g. because of the need to physically check passengers and their bags) and protection of personal information (e.g. by recording CCTV footage). Thus a key aim for policy- making when confronted with the security challenge should be to strike the appropriate balance across security, privacy and dignity, whilst maintaining efficiency and convienence (since although extensive checks would achieve security objectives they would also bring the infrastructure to a halt, thus contributing to the achievement of the goals of the terrorist acts).. In this context, it is important to capture and understand the citizens' perspectives. Capturing public preferences is the only way to ensure

public views are represented in the decision- and policy-making process. Moreover, eliciting citizens' preferences provides guidance on best practices for communicating potential threats from loss of privacy and offer reasons on how potential threats to privacy may be mitigated. Thus one of the key aims of this study is to contribute to this debate and provide robust evidence based on citizens' preferences for security and privacy in the context of rail/metro travel.

Using data from a pan-European survey, we investigate public preferences relating to data collected on train/metro facilities mainly for security and surveillance through the use of CCTV. The specific research questions include the following:

1. Do respondents prefer facilities where less data is collected?
2. Does the duration of data storage (retention) matter?
3. Do respondents prefer certain geographic level of access (sharing) to data by authorities and government agencies (i.e., home country, EU, internationally)?
4. Do these preferences vary across individuals and countries?

The pan-European survey was conducted as part of PACT – "Public perception of security and privacy: Assessing knowledge, Collecting evidence, Translating research into action", a three-year research project funded by the European Commission's 7th Framework Programme. The overall aim of PACT has been to understand public perceptions of security, privacy and surveillance across the 27 European Union Member States (EU27[1]). Among other research activities, PACT involved a survey questionnaire with three stated preference experiments each corresponding to the following choice contexts:

1. Travel on metro or train,
2. Choice of an Internet Service Provider, and
3. Purchasing a device or service for storing health-related personal data.

For the purposes of this paper, we only focus on travel on metro/train. Findings from this paper can inform on how planned security and surveillance measures on transport infrastructure facilities are perceived by users, providing the evidence base for informing regulations and best practices related to security and surveillance measures. This study also adds to the evidence on the applicability of stated preference methods for measuring perceptions related to security and privacy, which are frequently described as abstract and complex concepts.

LITERATURE REVIEW

Previous studies aimed at better understanding travellers' acceptance for travel-security and surveillance measures, have been limited in both their numbers and geographical context. Robinson (2010) and Potoglou et al. (2010) was one of the first quantitative studies to investigate preferences of travellers for privacy and security was reported in Robinson (2010 and Potoglou et al (2010). Their findings came from the analysis of a survey-based stated preference discrete choice experiment involving a little over 2,000 participants in the UK. The experiment involved varying surveillance and security settings that a traveller may encounter prior to a rail journey; the experiment presented respondents with potential benefits from the implementation of those measures (e.g. disruption of an incident and effective response of the authorities upon an incident taking place) as well as financial costs to cover security improvements and delays to go through

[1] At the time of inception of this project (in 2012) there were only 27 Member States of the EU. Croatia joined the EU in 2013 and was not included in the scope of this project.

security. Findings showed that UK respondents would accept standard and advanced CCTV surveillance and opted-in for non-physical security checks (X-ray imaging). On the other hand, they were less likely to select a scenario that involved physical security checks (pat-down and bag search). Finally, respondents were more likely to choose travel settings with more specialised security personnel at rail stations, except from non-white, non-conservative individuals who were less likely to opt-in for settings where uniformed military were present.

Following the 7/7 London bombings, the UK Department for Transport commissioned a number of trials in London underground and rail stations in England to capture passengers' acceptance levels and response to transport security measures involving full-body scanners and luggage X-ray and sniffer dogs (Turley and Stone, 2006a; 2006b cited in Carter et al., 2015). Follow up qualitative interviews and discussion groups with study participants revealed that full-body scanners were an issue particularly for younger and Muslim women, but less of an issue for men and older women. All study participants felt that all travellers should be subject to checks through a body scanner rather than a random sample of travellers. Participants also felt that conventional ways of scanning would cause delays and suggested that technologies should enable scanning whilst walking (Turley and Stone, 2006a; 2006b cited in Carter et al., 2015). London trials also involved traveller random stop-and-search where dogs sniffed closed luggage followed by physical checks by British Transport Police. Individuals expressed concerns about their dignity and also felt that physical search was embarrassing for them (Turley and Stone, 2006a; 2006b cited in Carter et al., 2015).

While the abovementioned studies provide detailed evidence from the UK, it is not entirely clear whether citizens of other European countries would similarly respond. This is quite important given that European policy is directed to citizens representing a wide array of cultures, languages and worldviews thus not necessary conventional with evidence coming from a single country. Therefore, this study is also aimed at addressing this gap in the literature by reporting on findings at the pan-European level.

Other studies of similar nature to the above report findings in the context of air travel. Viensten et al. (2011) elicit preferences for different security measures for mitigating the risk of aviation terrorism. Security screening type, travel time, cost and the impact expressed as number of fatalities because of a terrorist attack were the attributes employed to describe hypothetical air travel situations. The study was based on a discrete choice experiment which was administered via the Internet and involved 472 Norwegians. Each participant was presented with a scenario under which they had to be identified via a biometric identity card and if disqualified as 'low-risk passengers' they had to undergo through a body scanner. Respondents opted-in for protection of their privacy rather than going through a body scanner; even after circumstances where the perceived level of terrorist risk and subsequently the likelihood of preventing fatalities could be reduced. The study also aimed at computing the value of statistical life (VSL) respondents' placed upon an air terrorist attack, but the authors do highlight VSL values of €177 mil., an order of magnitude higher than those adopted by Scandinavian governments.

Also in the context of air-travel security, Dillon and Thomas (2015) examined the US general public's privacy concerns caused by body scanning and pat-down-body searches during passenger airport screening. The sample involved 860 adults who lived in the Mid-Atlantic States of New Jersey, Maryland, Pennsylvania and Virginia. Their study reported high levels of

trust on the security authorities by lower education-attainment participants. Security checks using full-body scanning was broadly acceptable by air travellers, however, there were differences across ethic groups; for example, Black, Hispanic and Asian and minority-religions individuals were less likely to accept full-body scanning. In addition, women were less likely to accept pat-down full body searching. Finally, Beck et al. (2015) examined the choice between two security processes when respondents were about to join an international flight from Australia. The survey was conducted following the MH370 and MH17 Malaysia Airlines disasters and involved 304 participants. The data collection involved astated preference experiment and incorporated attributes and levels developed by Potoglou et al. (2010) and Patil et al. (2014). Findings pointed towards three classes of travellers: (a) those who were 'trusting' the authorities and were willing to accept a range of security measures including privacy-intrusive measures; (b) those who were 'nervous' and would be willing to fly only with presence of security personnel (uniformed or not) on board the aircraft; and (c) 'status quo' travellers who felt that the current level of security provided sufficient protection.

To our knowledge, the only study on privacy and security conducted at multi-country level is by Carter et al. (2015) who conducted an online survey to elicit travellers' opinions, acceptability and perceived effectiveness of counter-terrorism measures at rail stations across England, Spain, Romania and Italy in 2013. Findings showed that security staff and security measures would reassure travellers. On the other hand, airport-style security checks were less popular and there were mixed responses about sniffer dogs and the storage of personal data. The authors did point out significant variation in preferences variationsacross British, Italian, Spanish and Romanian respondents; for example, Italians were more open to airport-style screening than British participants. Shortcomings of the study included the relatively small sample size, which also limited the opportunity to generalise the results given limited representation of countries. Finally, questions were purely opinion based with very little room to capture responses to varying settings of security and surveillance. This study addresses these shortcomings by collecting data across the EU27 with sample sizes varying from 750 to 1,000 participants per country.

The work reported in this study builds upon some of those previous efforts and is follow on work from the pilot of the project reported by Patil et al. (2014) and a previous study Robinson et al. (2010). It further makes an attempt to provide robust evidence based on the whether citizens would forgo some civil liberties in the name of security and convience, especially in the context of mass public-transport travel across EU27.

SURVEY INSTRUMENT AND DATA

The survey questionnaire was developed using contributions from the project consortium consisting of experts in security and privacy along with stakeholder consultation, expert interviews and focus groups. The scenarios in the stated preference experiments were extensively tested through cognitive interviews and pilot surveys. The pilot surveys were conducted in Denmark, Italy and Romania in May 2013 by surveying about 50 respondents in each of these countries (PACT D2.3 2014). Using the feedback from the pilot surveys and cognitive interviews the questionnaire was simplified and modified significantly. An additional small pilot was deemed necessary to test the modified questionnaire. Accordingly, a second smaller pilot survey (with 50 respondents) was undertaken in Romania in July 2013 before starting the main stage of data collection. The fieldwork for the main stage of data collection in each of the EU27 countries

was carried out from August to November 2013 (see PACT D3.2, 2014 for details). Respondents were selected (according to quotas for age, gender and region) to participate either in an online or face-to-face interview. Online surveys were conducted in 12 countries with comparatively higher Internet penetration whereas face-to-face interviews took place in the 13 countries with lower Internet penetration. In Italy and Germany, a mixed methods approach- using both types of interviews- was used to allow us to examine and control differences by survey mode.

Each respondent participated in up to two stated preference experiments from the three potential contexts. It should be noted that the time period for the main stage fieldwork overlapped with publications in the news about National Security Agency (NSA) and Government Communications Head Quarters (GCHQ) secret surveillance, which might have conceivably influenced some responses due to heightened awareness of issues relating to privacy.

Survey Instrument

Stated preference experiments have been used extensively in the fields of marketing, transport economics, environmental valuation, health and healthcare (Louviere, 1992; Louviere et al. 2000; Louviere and Woodworth, 1983; Ryan et al. 2001). Using experimental design principles, the researcher constructs a series of hypothetical choice scenarios from a combination of attributes and levels describing the alternatives in a choice scenario. In each choice scenario, the respondent is asked to indicate the most preferred alternative (Figure 1). Using discrete choice models, the analysis of these preferences can yield information on the relative importance of the attributes used to describe the alternatives.

Robinson et al. (2010) and Veisten et al. (2011) have recently used the stated preference experiments in the field of travel security and privacy; however, these studies frame the choice scenarios differently and do not include the privacy issues related to data protection. In this study, we apply this method for a travel choice involving security measures both with and without privacy implications. Thus the preferences provided by respondents are based on their perceptions related to effectiveness of security and surveillance measures and likelihood of violation of privacy. We explicitly avoid referring to the effectiveness of security measures (or lack of it) and subsequent possible violation of privacy (or lack of it). However, we do ask respondents prior to the stated preference questions to indicate if they have witnessed or experienced any of the security threats involved in train/metro travel and how concerned they are regarding privacy issues arising out of surveillance. The objective of asking these questions was to make respondents aware of different security and privacy issues involved in train/metro travel before they were presented with the stated preference questions. These questions also provide an opportunity to obtain insight into the preferences regarding some attributes which are not included in the stated preference questions to avoid information overload.

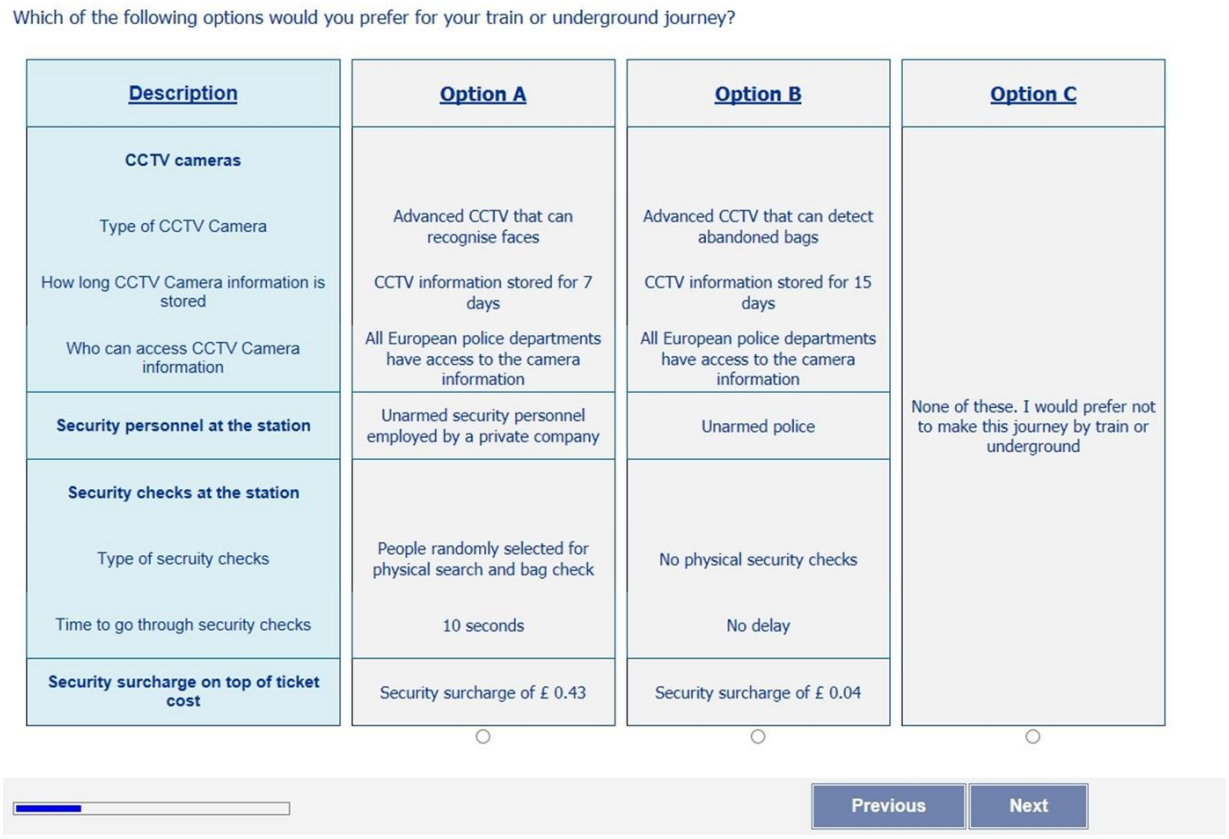

FIGURE 1 Example of the stated preference experiment in PACT.

The stated preference experiment in this study involved asking respondents to indicate their preferred setting when travelling by metro or train. Only respondents who indicated that they previously travelled by train/metro were presented the stated preference questions. Each alternative was described using different attributes and levels (Table 1). Different configurations of levels across all the attributes differentiated one alternative from another in a given choice scenario. The choice scenarios were generated using an experimental design. Full questionnaire including the details on experimental design are described in PACT's project deliverable (PACT D2.3, 2014).

Data

Approximately 1,000 respondents aged 18 and older were interviewed in all the countries except for Luxembourg, Malta, and Cyprus where about 750 responses were collected due to smaller population sizes. About half of all the respondents answered questions on travel context which is relevant for this paper. Each respondent answered five stated preference exercises resulting into a total of 64,785 choices from 12,957 respondents. About 6.7% of the observations are excluded because they could be possibly unreliable (based on reported understanding of the experiment and unrealistically less time taken to complete the exercise). Further, excluding the missing responses leaves 60,472 observations (choices) for the stated preference modelling exercise. Further details on sample sizes by country and survey mode are provided in PACT D4.1 (2014).

1 **TABLE 1 Attributes and Levels in the Metro/Travel Choice Scenarios**

Attribute	Details	Levels
Type of CCTV cameras	This attribute describes if a CCTV camera is used and its features.	Standard CCTV – working like a television
		Advanced CCTV that can detect abandoned bags
		Advanced CCTV that can recognise suspicious movements of people
		Advanced CCTV that can recognise faces
		No CCTV cameras
How long CCTV Camera information is stored?	Time period CCTV data may be stored (conditional on presence of CCTV)	CCTV information not stored for future use-only used in real time monitoring
		CCTV information stored for 3 days
		CCTV information stored for 7 days
		CCTV information stored for 15 days
		CCTV information stored for 45 days
Who can access CCTV Camera information?	Type of authorities who may access the CCTV data (conditional on presence of CCTV), Level 1 corresponds to the respondent's country of residence [e.g. UK, FR]	Only police departments in the [UK] have access to the camera information
		All European police departments have access to the camera information
		All police departments worldwide have access to the camera information
Security personnel at the station	Type of security personnel, if present	No security personnel
		Unarmed security personnel employed by a private company
		Armed security personnel employed by a private company
		Unarmed police
		Armed police
Type of security checks at the station	Type of security measures when deployed	People randomly selected for physical search and bag check
		People randomly selected to go through metal detector or full body scanner
		No physical security checks
Time to go through security checks	Delay incurred due to security checks (No delay if no security measure deployed)	10 seconds
		30 seconds
		1 minute
		2 minutes
		5 minutes
		No delay
Security surcharge on top of ticket cost (per trip)	Levels are adjusted to display cost in Euro or local currency (e.g. £)	No security surcharge
		Security surcharge of 0.05 Euro
		Security surcharge of 0.10 Euro
		Security surcharge of 0.30 Euro
		Security surcharge of 0.50 Euro

		Security surcharge of 1.00 Euro

MODELING APPROACH

The responses obtained through the choice experiments are analysed using a multinomial logit model. The model is based on the principle of Random Utility Maximisation (RUM) (Ben-Akiva and Lerman, 1985; Marschak, 1974; McFadden, 1978). According to RUM, a respondent choses an alternative which provides maximum utility. Utility is a latent construct divided in two components; a deterministic and a random (error) component. The deterministic component of the utility can be specified using observable variables which are likely to affect the respondent's choice as follows:

$$V_{ij} = ASC_j + \sum_{k=1}^{K} \left(\beta_{jk} X_{jk}\right) \quad (1)$$

where:
V_{ij} is deterministic component of utility for individual i and alternative j
ASC_j is the alternative specific constant of the alternative j
X_{jk} is k^{th} variable which describes the alternative j, k=1,.., K
β_{jk} is the coefficient to be estimated

The multinomial logit model assumes that the error components are extreme value (or Gumbel) distributed, and the choice probability P_{ij} of an alternative j for individual i is given by Equation 2.

$$P_{ij} = \frac{exp(V_{ij})}{\sum_{j=1}^{J} exp(V_{ij})} \quad (2)$$

The multinomial logit model used in this study has been developed using the data from all the respondents in the EU27 countries. Hence, a single weight is estimated for each of the attribute levels, which could be interpreted as the EU average value. However, even in this case, when pooling data from different country samples it is necessary to consider the possible variation in the unobserved factors or error-variation in the models between countries. These can include different measurement errors across samples and other unobserved cultural and contextual factors. Furthermore, surveys in some countries were carried out online, while others were undertaken 'face to face'. These two types of survey modes may also give rise to variations in unobserved factors or error-variation in the models, which need to be controlled for. Accordingly, the variation in quality of responses across the following two dimensions is taken into account:

- Country scales to control for country-specific unobserved factors such as difference in quality of data and survey implementation across the EU27.
- Scales by survey methodology to control for variation in response quality between the online and face-to-face survey methodologies.

Further, to account for correlations between multiple stated preference responses from one respondent, a panel specification can be specified. A panel specification however increases the model estimation time considerably for the large dataset we are using. Hence in order to correct for model mis-specification and to take into account the repeated nature of the SP data we use bootstrap resampling procedure on the final model (Efron and Tibshirani, 1994).

RESULTS AND DISCUSSION

In this section we present the results of the discrete choice models of stated preferences related to CCTV data privacy and other security measures. The summary of experiences related to security threats and privacy concerns as captured by questions before the stated preference questions is also presented in this section.

Security threats in train/metro travel

Figure 2 shows the various security threats that respondents across EU27 have either experienced or witnessed during a metro/train journey. The following observations can be drawn from Figure 2:

1. Pick-pocketing has been experienced by 9% of the respondents while travelling on a metro/train and 13% of the respondents witnessed an act of pick-pocketing.
2. More than 50% of the respondents have witnessed anti-social behaviour and fare evasion.
3. More than 20% of the respondents have witnessed vandalism and violence during their journeys.
4. 3% of respondents stated that they have experienced terrorism.

These experiences are likely to affect preferences related to security and surveillance measures.

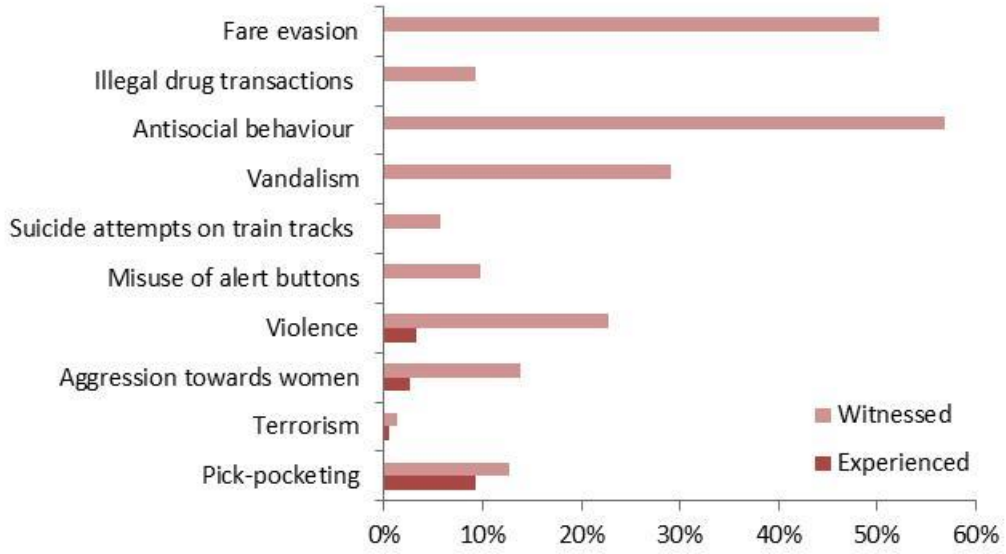

FIGURE 2 Proportion of respondents who have experienced or witnessed security threats.

Privacy Concern across EU27

Respondents' concern for privacy while travelling are collected on a Likert-type scale ranging from 'Not concerned at all' to 'Very concerned' based on their responses to the following question:

How concerned are you about the following when travelling by train or metro?

- *Misuse of CCTV camera images by the authorities*
- *Misuse of travel data (travel origin, destination, frequency) for tracking a person's whereabouts*
- *Misuse of security measures for sexual or racial harassment*
- *Sharing travel data and CCTV images across and outside the EU.*

Table 2 presents a summary of responses capturing privacy concern across the EU27. While each of these four statements reflects a different type of privacy threat, it can be observed that the percentage of respondents with each level of concern is broadly similar across all four statements.

TABLE 2 Privacy concerns across EU27

	1 (not concerned at all)	2	3	4	5 (very concerned)	Total Number of Responses
Misuse of CCTV camera images by the authorities	32.4%	22.0%	22.2%	13.8%	9.6%	12,720
Misuse of travel data (travel origin, destination, frequency) for tracking a person's whereabouts	28.3%	22.2%	23.4%	15.7%	10.4%	12,742
Misuse of security measures for sexual or racial harassment	29.0%	20.5%	23.3%	15.5%	11.7%	12,693
Sharing travel data and CCTV images across and outside the EU	27.3%	20.5%	24.5%	16.1%	11.6%	12,670

Accordingly, an overall index which represents the respondents' concern for privacy while travelling is derived based on the number of 'concerned' responses to the above statements. Respondents are classified into four categories: High Concern (3 or more 'concerned' responses); Medium Concern (2 'concerned' responses); Low Concern (1 'concerned' response) and No Concern.

Figure 3 shows the variation in proportion of respondents with 'High Concern' for privacy in Travel context across the EU27. The following observations can be drawn:

1. The highest proportions of respondents with 'No Concern' for privacy in the Travel context are observed in the Nordic countries (Denmark, Sweden and Finland), and in Slovakia and Netherlands.
2. The highest proportion of respondents with 'High Concern' for privacy in the Travel context are observed in southern European countries (Spain, Greece and Portugal) and central eastern European countries (Latvia, Lithuania and Bulgaria).

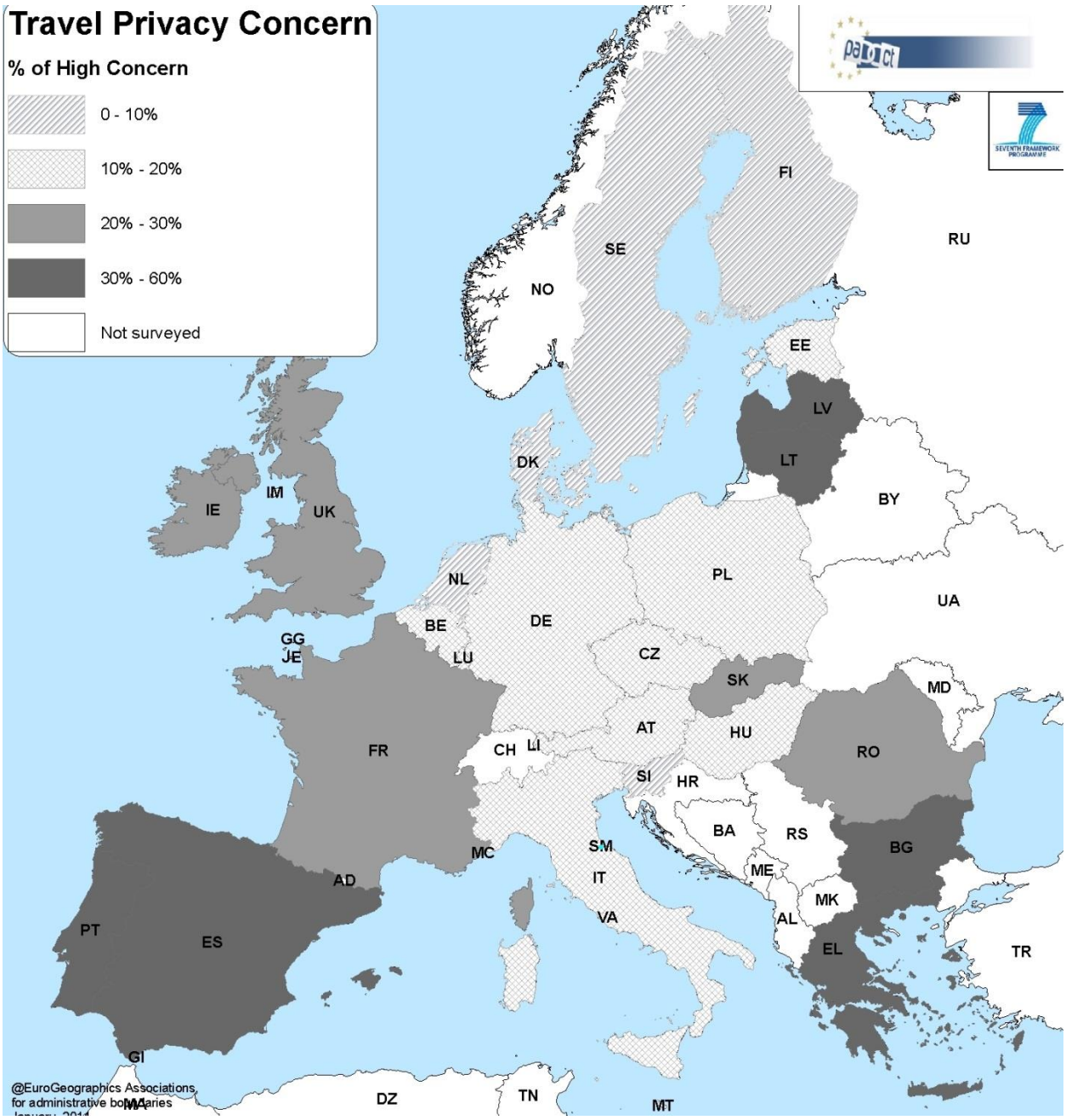

FIGURE 3 Proportion of respondents with high travel-privacy-concern index.

Results of the discrete choice model

Table 3 presents estimated parameters of the multinomial logit model. Since the choice scenario involves three unlabelled alternatives only one alternative specific constant is estimated, placed on the utility of the "None of these" alternative (labelled 'none' in Table 3). This constant is specified to be country specific including a separate constant for methodology in Italy and Germany where both online and face-to-face surveys were used.

The effects of socio-economic variables such as age, gender, income, education level and working status on the preferences relating to security and surveillance are also included in the discrete choice models. Only the statistically significant coefficients at a 95 per cent level of confidence are retained in the final model specification.

Preferences across EU27 countries

We observe broadly similar preferences across countries. Where the preferences differ significantly in a given country these are specifically identified and the effects are presented in Figures 4 to 6 (the definition of country acronyms can be found in the Appendix). The values shown in these charts are expressed in units of utility in order to highlight differences in *relative* preference across countries. Furthermore, bars to the right of the vertical axis represent positive preferences and those to the left represent disinclination. The length of a bar is indicative of the strength of a preference relative to the baseline of each attribute. In each figure, the series marked by 'all other' refers to the EU27 countries, excluding the countries identified in the chart. The 'all other' group is therefore, in most cases, representative of respondents in most EU countries. It should be noted that the 'all other' group also includes the reference level of significant socio-economic effects. However, confounding of these effects should not affect the relative comparison of utilities between countries (note that the socio-economic effects are not specified to be country specific).

Type of CCTV camera

In most EU27 countries, respondents prefer CCTV cameras when compared to the reference level, 'No CCTV'. As shown in Figure 4, respondents' preferences for the types of CCTV are in the following order: (1) advanced CCTV that can detect faces, (2) CCTV that can detect abandoned bags, (3) CCTV that can recognise suspicious movements of people, and finally, (4) standard CCTV (which works like a television).

However, the strength of preference for the different CCTV camera types differs across eleven countries. While all types of CCTV cameras are still preferred over 'No CCTV' in these countries, the magnitude of preference varies. We observe stronger preference for all types of cameras in France, and stronger preference for standard CCTV cameras over other camera types in Sweden, whereas in Bulgaria, the Czech Republic, Denmark, Greece, Hungary, Latvia, Poland, Portugal and Slovakia the preference for CCTV cameras is weaker compared to other countries in the EU27.

TABLE 3a Model Results- Main effects

Summary statistics			
Observations		60,472	
Final Log Likelihood		-61,319.3	
D.O.F		137	
Rho²(0)		0.077	
Rho²(c)		0.054	
Description	**Label**	**Coefficient**	**t-ratio**
Type of CCTV cameras			
Standard CCTV – working like a television	cam_std	0.8358	12.64
Advanced CCTV that can detect abandoned bags	cam_bag	0.9429	13.15
Advanced CCTV that can recognise suspicious movements of people	cam_sus	0.8718	12.69
Advanced CCTV that can recognise faces	cam_face	0.9785	13.24
No CCTV cameras	cam_none	0	n/a
How long CCTV camera information is stored			
CCTV information not stored for future use – only real-time monitoring	dur_rt	0.0000	n/a
CCTV information stored for 3 days	dur_3d	0.1801	6.82
CCTV information stored for 7 days	dur_7d	0.3156	9.80
CCTV information stored for 15 days	dur_15d	0.3225	10.09
CCTV information stored for 45 days	dur_45d	0.1666	6.23
Who can access CCTV camera information			
Only police departments in the [UK] have access to the camera information	acc_op	0.0000	n/a
All European police departments have access to the camera information	acc_eu	-0.1261	-6.83
All police departments worldwide have access to the camera information	acc_int	-0.2327	-9.72
Security personnel at the station			
No security personnel	per_none	0	n/a
Unarmed security personnel employed by a private company	pers_pvt	0.3115	10.24
Armed security personnel employed by a private company	pers_ta	0.2336	8.32
Unarmed police	pers_pol	0.4450	11.78
Armed police	pers_arm	0.2205	7.83
Type of security checks at the station			
People randomly selected for physical search and bag check	sec_pd	-0.2449	-9.50
People randomly selected to go through metal detector or full body scanner	sec_md	-0.0318	-1.65
No physical security checks	sec_none	0	n/a
Time to go through security checks			
10 seconds 30 seconds 1 minute 2 minutes 5 minutes	time	-0.0003	-8.55
Security surcharge on top of ticket cost			
HH Income less than €500	cost_1t4	-0.0074	-10.05
HH Income from €500 to €1,250	cost_5t6	-0.0059	-10.28
HH Income from €1,250 to €5,000	cost_7t14	-0.0040	-11.40
HH Income greater than €5,000	cost_gt14	-0.0033	-5.17
Missing Income (Low-income countries)	cost_NA_L	-0.0134	-10.16
Missing Income (Medium-income countries)	cost_NA_M	-0.0066	-7.02
Missing Income (High-income counties)	cost_NA_H	-0.0071	-3.11

1 **TABLE 3b Model Results- Country and socio-economic interaction effects**

Description	Label	Description	Coefficients	t-ratio
Type of CCTV cameras				
Standard CCTV – working like a television	cam_std_SE	Sweden	0.2534	3.76
Advanced CCTV that can recognise faces	Camface_HU	Hungary	-0.2254	-3.39
No CCTV cameras	Nocam_BG	Bulgaria	0.5875	6.12
	Nocam_CZ	Czech Republic	0.7531	9.31
	Nocam_DK	Denmark	0.4228	5.52
	Nocam_EL	Greece	0.6566	7.69
	Nocam_FR	France	-0.3605	-1.86
	Nocam_HU	Hungary	0.5636	7.07
	Nocam_LV	Latvia	0.5504	4.92
	Nocam_MT	Malta	0.0000	n/a
	Nocam_PL	Poland	0.4607	4.24
	Nocam_PT	Portugal	0.7008	6.45
	Nocam_SK	Slovakia	0.6238	6.44
	Nocam_male	Male	0.1715	5.20
	Nocam_1824	Age group 18–24	0.0954	1.91
	Nocam_5564	Age group 55–64	-0.1268	-2.98
How long CCTV camera information is stored?				
CCTV information not stored for future use –only real-time monitoring	dur_rt_AT	Austria	0.1858	2.27
	dur_rt_EL	Greece	0.3542	4.65
	dur_rt_EE	Estonia	-0.3248	-3.68
	dur_rt_IE	Ireland	-0.2105	-2.84
CCTV information stored for 45 days	dur_45d_MT	Malta	0.0000	n/a
	dur_45d_ES	Spain	0.2400	3.33
	dur_45d_CZ	Czech Republic	-0.2153	-2.89
Who can access CCTV camera information				
All European police departments have access to the camera information	acc_eu_LV	Latvia	-0.2672	-2.78
All police departments worldwide have access to the camera information	acc_int_DE	Germany	-0.3473	-3.74
Security personnel at the station				
No security personnel	nospers_BE	Belgium	-0.2234	-2.87
	nospers_CY	Cyprus	-0.6167	-2.83
	nospers_CZ	Czech Republic	0.2399	3.94
	nospers_DE	Germany	0.2673	4.89
	nospers_ES	Spain	-0.4031	-4.99
	nospers_FR	France	-0.5466	-3.33
	nospers_HU	Hungary	0.2722	4.29
	nospers_IT	Italy	-0.2368	-2.66
Unarmed security personnel employed by a private company	perspvt_FR	France	-0.4115	-3.60
Armed security personnel employed by a private company	persta_DE	Germany	-0.4010	-5.58
	persta_EE	Estonia	0.1403	2.04
	persta_FR	France	-0.3465	-2.95
	persta_IE	Ireland	-0.2299	-3.60
	persta_UK	UK	-0.2682	-3.95
Armed police	persarm_BE	Belgium	0.2361	3.51
	persarm_FR	France	0.3735	3.67
	persarm_PL	Poland	-0.3400	-3.28

Type of security checks at the station				
No physical security checks	nosec_AT	Austria	0.2671	4.57
	nosec_CZ	Czech Republic	0.2064	3.62
	nosec_DE	Germany	0.4974	5.51
	nosec_DK	Denmark	0.1342	2.83
	nosec_ES	Spain	-0.1416	-2.88
	nosec_FR	France	-0.1850	-2.83
	nosec_IT	Italy	-0.2843	-4.26
	nosec_LV	Latvia	0.3802	4.23
	nosec_PL	Poland	0.3058	3.50
	nosec_SE	Sweden	0.2332	3.99
	nosec_SI	Slovenia	1.1783	2.76
	nosec_SK	Slovakia	0.2648	3.47
	nosec_UK	UK	-0.1284	-2.46
People randomly selected to go through metal detector or full body scanner	sec_md_BG	Bulgaria	0.1959	3.00
	sec_md_LU	Luxembourg	-0.2542	-3.50
	secmd_1824	Age group 18–24	0.0602	1.73

TABLE 3c Model Results- Country and socio-economic effects on scales and the constant

Scales				**None constant**			
Country	**Label**	**Coef.**	**t-ratio**	**Country**	**Label**	**Coef.**	**t-ratio**
Austria	Scale_AT	1.0000	n/a	Italy (Face)	None_IT_F	-0.0944	-0.7
Belgium	Scale_BE	1.1690	10.8	Italy (Online)	None_IT_O	0.1007	1.0
Bulgaria	Scale_BG	1.0387	6.6	UK	None_UK	0.2613	4.0
Cyprus	Scale_CY	0.8774	5.3	Sweden	None_SE	0.9846	11.5
Czech Republic	Scale_CZ	1.4830	6.7	Spain	None_ES	0.2735	4.0
Denmark	Scale_DK	1.5837	9.2	Slovenia	None_SI	0.9659	4.4
Estonia	Scale_EE	1.0703	10.7	Slovakia	None_SK	0.5923	7.2
Finland	Scale_FI	1.0903	11.0	Romania	None_RO	-0.4055	-2.5
France	Scale_FR	0.9150	6.7	Portugal	None_PT	0.5911	6.9
Germany	Scale_DE	0.9054	8.9	Poland	None_PL	0.8790	9.9
Greece	Scale_EL	1.3550	6.6	Netherlands	None_NL	0.3597	4.8
Hungary	Scale_HU	1.6390	6.9	Malta	None_MT	-0.2613	-1.7
Ireland	Scale_IE	1.1664	11.3	Luxembourg	None_LU	0.3513	4.2
Italy	Scale_IT	1.0825	9.6	Lithuania	None_LT	0.1498	0.6
Latvia	Scale_LV	1.0086	6.3	Latvia	None_LV	-0.6409	-3.4
Lithuania	Scale_LT	0.6654	3.4	Ireland	None_IE	0.3804	6.0
Luxembourg	Scale_LU	0.9271	9.5	Hungary	None_HU	1.0252	12.0
Malta	Scale_MT	1.0878	6.3	Greece	None_EL	0.3892	4.5
Netherlands	Scale_NL	0.9444	9.9	Germany (Face)	None_DE_F	0.4230	3.8
Poland	Scale_PL	1.1924	6.4	Germany (Online)	None_DE_O	0.7058	7.5
Portugal	Scale_PT	1.0543	6.3	France	None_FR	-0.0833	-0.5
Romania	Scale_RO	0.6846	6.2	Finland	None_FI	0.7701	10.8
Slovakia	Scale_SK	1.1285	6.4	Estonia	None_EE	0.0811	1.0
Slovenia	Scale_SI	0.4128	3.6	Denmark	None_DK	1.1011	12.4
Spain	Scale_ES	1.2204	11.1	Czech Republic	None_CZ	0.9664	11.4
Sweden	Scale_SE	1.1708	11.0	Cyprus	None_CY	0.2371	1.6
UK	Scale_UK	1.1836	11.1	Bulgaria	None_BG	-0.6235	-3.7
Survey method effects				Belgium	None_BE	0.5128	7.2
Online	Scale_O	1.0000	n/a	Austria	None_AT	0.7045	8.5
Face to Face	Scale_F	0.8298	10.3				

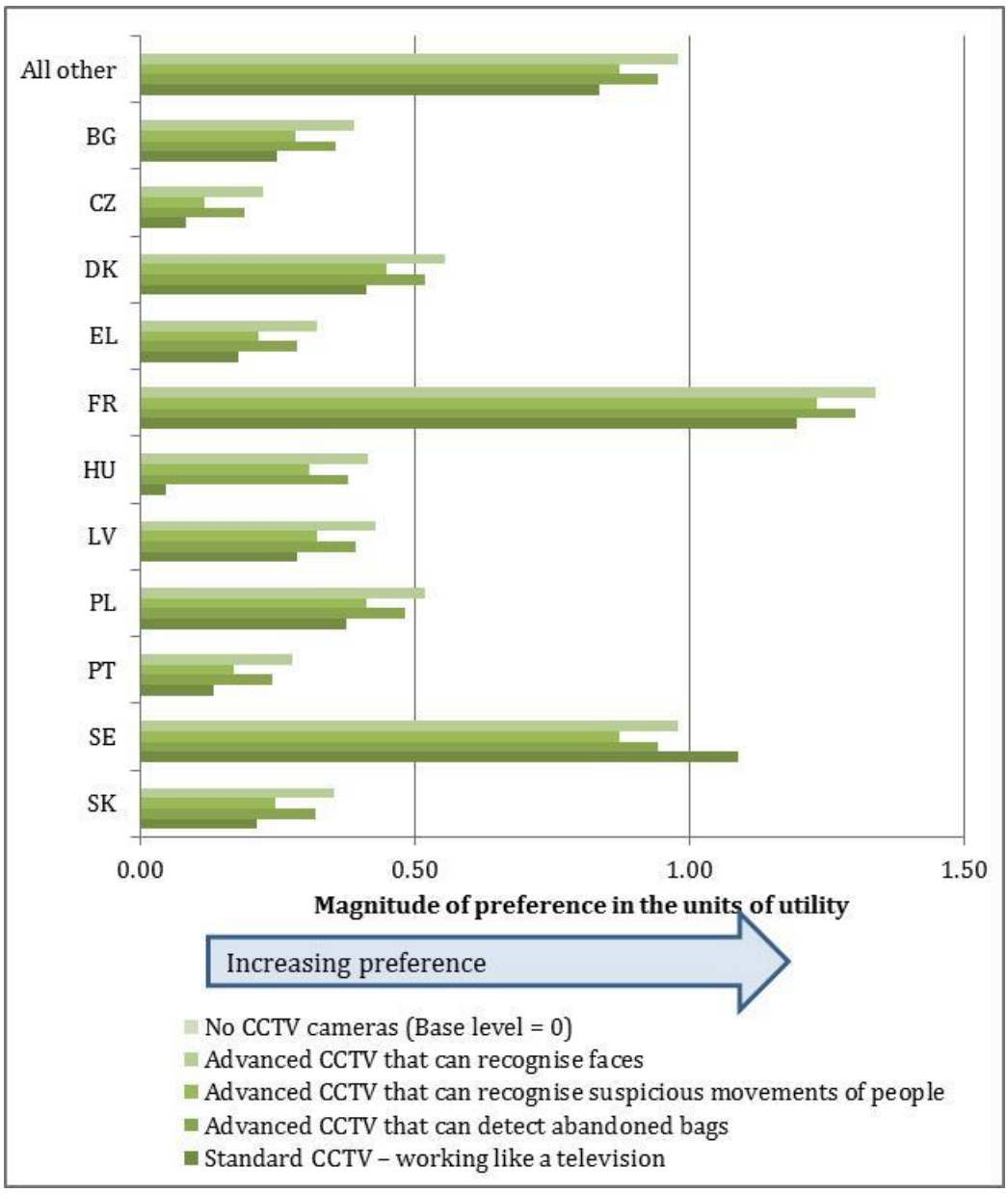

FIGURE 4 Relative preferences for different types of CCTV across the EU27.

Duration of storage

In most EU27 countries, given that CCTV cameras are used, respondents prefer that CCTV information is stored for future use, relative to the reference level that CCTV information is only used for real-time monitoring. The magnitude of the coefficients for the duration of storage indicates the respondents' order of preference for storing CCTV information. We observe a U-shaped pattern: 15 days' storage time is the most preferred, followed by 7 days and 3 days whereas 45 days is the least preferred (see, Figure 5).

Contrary to the above preferences in most EU27 countries, respondents in Greece indicate a strong aversion to storage of CCTV data and prefer only real-time monitoring. This outlying dispreference for storage of surveillance data in Greece could be due to a history of authorative surveillance in the country (see, Samatas (2002, 2008) for details). Furthermore, respondents in

the Czech Republic show disinclination towards storage of CCTV data for 45 days and those in Spain prefer storage for longer durations over shorter ones. Respondents in Estonia and Ireland indicate stronger preferences for data storage over real-time use compared to other countries in the EU27. Respondents in Austria prefer real-time use and medium-term storage (7 to 15 days).

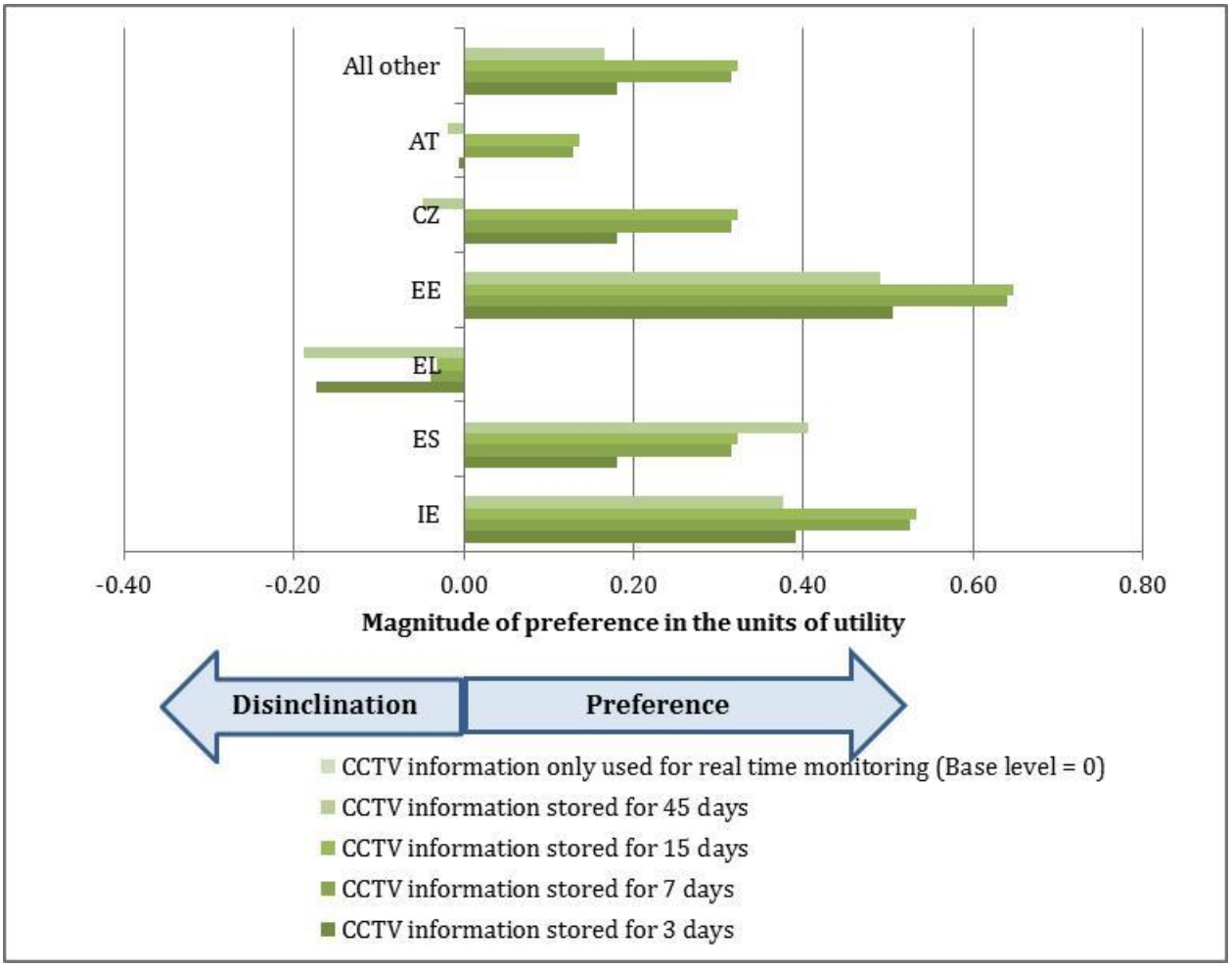

FIGURE 5 Relative preferences for duration of storage of CCTV data

Access to CCTV data

Across the EU27, respondents show a disinclination towards the option of CCTV information being accessed by police departments outside their home country (across Europe and worldwide), although they are more averse to CCTV information being shared among all police departments worldwide than across only European police departments. Respondents in Germany indicate a stronger disinclination towards the option of providing access to all police departments worldwide compared to other countries in the EU27. Respondents in Latvia are more averse to CCTV information being shared across Europe than other countries in the EU27. These effects are shown in Figure 6.

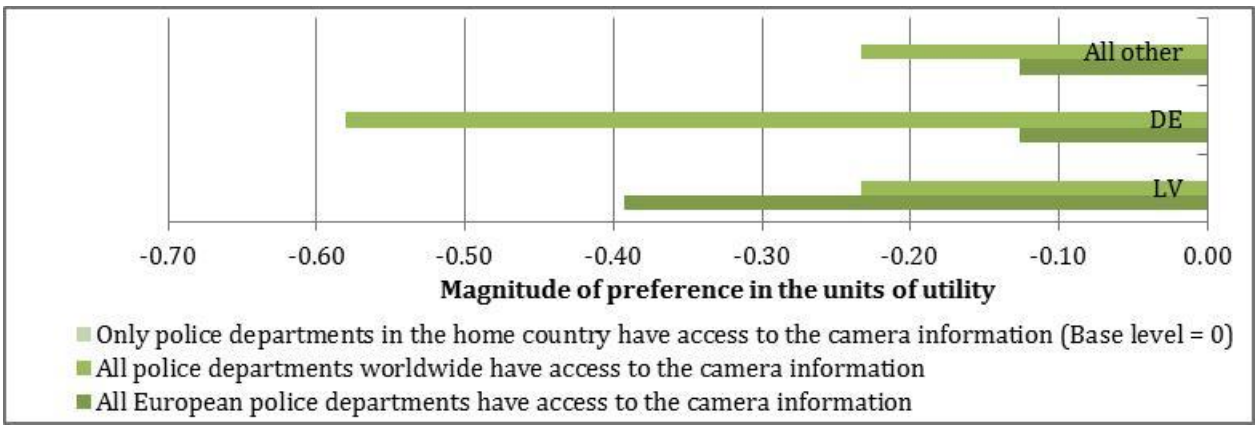

FIGURE 6 Relative preferences for geographic level of access to CCTV data

Security Personnel

In most EU27 countries, respondents prefer having security personnel at train/metro stations relative to the reference level of 'No security personnel'. Unarmed police is the most preferred option, followed by unarmed security personnel employed by a private company and armed police; armed security personnel employed by a private company are least preferred.

Preferences in favour of security personnel are stronger in Belgium, Cyprus, France, Spain and Italy compared to other countries in the EU27, whereas they are lower in the Czech Republic, Germany and Hungary. Contrary to the pattern in other countries, respondents in Germany, Hungary and the UK indicate disinclination towards armed security personnel employed by a private company when compared with settings involving no security personnel. Respondents in Germany and Hungary also indicate disinclination towards armed police, along with those in Czech Republic and Poland. Armed security personnel employed by a private company are also less preferred than other security personnel in France and Ireland (however, they are still preferred over having no security personnel), whereas in Estonia they are preferred over unarmed personnel employed by a private company. In Belgium and France, armed police are the most preferred type of security personnel, with respondents in France indicating stronger preference for police (armed/unarmed) over private security personnel.

Security Checks

Respondents across Europe are averse to having to go through physical security checks, and are more averse to physical searches that include a bag search than going through a full body scanner or metal detector. However, the disinclination towards a physical check involving a metal detector/full body scanner compared to no physical checks becomes statistically insignificant after controlling for the country and socio-economic variables.

In more than half of the EU27 countries, respondents exhibit significantly different preferences for security checks. In Austria, the Czech Republic, Germany, Denmark, Latvia, Poland, Sweden, Slovenia and Slovakia the disinclination is stronger and significant for both types of physical checks. However, respondents in Spain, France and the UK indicate a weaker disinclination towards physical searches that include a bag search and indicate a preference for having a physical check involving a metal detector/full body scanner over no physical security check. These three countries have experienced terrorist attacks on public transport facilities in recent years – which could explain these preferences. Respondents in Italy prefer both types of

physical security checks over no physical security checks, whereas those in Bulgaria prefer a physical check involving a metal detector/full body scanner. Respondents in Luxembourg exhibit a stronger disinclination towards metal detectors/full body scanners compared to physical searches and bag checks.

Delays due to security checks

All respondents prefer travel options that take less time to avoid any additional delay due to security checks. No country-specific or socio-economic effects were identified in this attribute.

Security surcharge on top of the ticket (cost)

Respondents also dislike paying additional security surcharges. Individuals with households with higher monthly incomes are less sensitive to increases of security surcharge on top of the ticket (decreasing cost sensitivity with increasing income). In the model, we have merged the 17 income bands into four aggregate bands (monthly income of less than €500, €500 to 1,250, €1,250 to 5,000, and greater than €5,000) – grouping the adjacent bands when the coefficients are not statistically different for individual income bands. A significant proportion (13.7 per cent) of respondents refused to report their income, as they answered 'prefer not to say' or 'don't know'. A separate coefficient for surcharge on top of the ticket cost is estimated for this group of respondents. Furthermore, the respondents in this group are split by country of residence using low-, medium- and high-income country groups to account for the wide range of average income across the EU27. Thus the final model contains cost coefficients for seven different groups based on their answers to the income question.

Differences by socio-economic status

We also tested differences in respondents' preferences based on age (18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64 and 65 plus), gender, working status (full time, part time, looking after family, unemployed, student, retired, not in work due to disability, seeking work, and other), education level, income, and location of residence (big city, suburb, town, village, countryside/farm). These effects are tested on all attribute levels (except on attributes delay and cost) and on the constant for the 'none of these' alternative. We observe the following significant effects:

- Respondents of all age groups and across the EU27 prefer CCTV cameras than 'No CCTV'. However, the preference is weaker for young people (aged 18 to 24) and stronger for those aged between 55 and 64. In addition, we observe that while both males and females prefer CCTV cameras, females have stronger preference for CCTV cameras compared to males.
- Young respondents (aged 18 to 24) across the EU27 have a stronger disinclination towards physical checks involving metal detectors/full body scanners compared to other age groups. Also, young people (aged 18 to 24) show a stronger disinclination towards choosing the 'none of these' alternative – indicating that they are more likely to choose alternatives A and B, which present a combination of security, surveillance and privacy levels.

CONCLUSION

This paper presents empirical evidence from a EU27-wide survey aimed to examine individuals' preferences for different aspects of data privacy in the context of train/metro travel in Europe. The preferences are collected across seven dimensions each forming an attribute taking different levels in a stated preference experiment. These dimensions include type of surveillance technology (CCTV spanning basic to advanced features), the storage time for surveillance data, geographic level of data access by police authorities (i.e., country of residence, EU, worldwide), level of specialisation of security personnel, type of security checks, delays to go through these security checks, and potential surcharge to cover security costs.

Overall, Europeans were in favour of surveillance using CCTV with most popular preference being for CCTV technology that can detect faces. We did, however, observe cross-country variations; respondents in Bulgaria, the Czech Republic, Denmark, Greece, Hungary, Latvia, Poland, Portugal, and Slovakia expressed lower strength of preference than other counties. Respondents across all countries were in favour of a 15-day storage period of footage recorded via CCTV, except in Greece. Czech's were averse to options that involved storage of footage for 45 days and the Spanish were in favour of longer than shorter periods of storing CCTV footage. Respondents prefered that the disclosure of CCTV data should be limited to police within the home country rather than shared with police authorities across Europe or Worldwide. With regard to security personnel at train/metro stations, Europeans would prefer unarmed police officers at stations over unarmed police and private security personnel. Again preferences for security personnel exhibited cross country variations; for example, respondents in Belgium and France preferred armed police over the unarmed police. Respondents were in favour of passive security checks such as body scanners and metal detectors and were averse to physical checks, but again with significant differences in strength of preference across countries. Finally, respondents were less likely to choose travel settings that involved increased delays and security surcharges against security. There could be a number of reasons for the variation in prefrences in some of the countries, including – culture, history of surveillance, history of terrorist attacks on public transport facilities, etc.

There were three particular cases which shed light on the role that past context and history plays in peoples preferences. Our research revealed a marked divergence in how Greek respondents viewed the storage of CCTV data, compared to other countries. This may be due to a number of reasons, notably the storage of records associated with Communist sympathizers during the civil war (1945-49) or the time of the military dictatorship in Greece (1967-1974). This historical legacy could have resulted in a general distrust of any collection of records (Mitrou, et al 2014). Nonetheless, the observation is interesting since one would expect, given the strong legacy of a surveillance state in East Germany during the Cold War (1951-1991) that Germany would be the divergent country in regard to this attribute. The fact that they, nor any of the other Eastern European countries where state surveillance was endemic (Hungary, Romania; Czech Republic etc.) were divergent is also perhaps revealing about the familiarity to such surveillance measures (or that these countries have more CCTV relative to the others).

There is a second interesting divergence in regard to the identified prferences of German respondents, who are shown by our analysis to dislike armed security at train/metro stations relative to other countries. Whilst at first glance Germany, especially in the 1930-1940s may present an obvious answer the reality may be more complex. In Germany, law enforcement is soley

the responsibility of the State, in particular police and municipalities departments of public order (Frevel, 2013). Private security is restricted and private secrurity firms, as elsewhere, cannot use force or arrest individuals. Since Germany is a federal state, there are specific federal-level police departments rather than a general national police force. The federal nature of the country with its 16 lander (states) may also play a role, if only to demonstrate that reluctance for public/private personnel to carry firearms transcends state borders.

Finally, the third inter-country difference concerns respondents in Bulgaria, UK, Spain, France and Italy displaying dislike of metal detectors / full body scanners compared to respondents from other countries. For Bulgaria, the answer may lie in the absence of such technologies of this kind of infrastructure; Sofia's metro is small consistiting of two lines. For the other countries, this may be due to the effect of the country has been subject to terrorist attacks, especially the UK and Spain where prior to the fieldwork there have been terrorist attacks launched against metro/rail infrastructures.

Overall, analysis of the data illustrates the complexity of the privacy / security debate as it pertains to transportation infrastructures. In particular, the increased use of transportation user data for various reasons outlined above (efficiency, safety and security) can pose complex social and ethical challenges to users, especially around perceptions of consent, accountability and transparency.

Privacy as a term is regarded as highly malleable (Solove, 2011) and the results presented here illustrate that in the context of transportation infrastructure, challenges to privacy are seen as stemming from invasions into the person space of users (through pat downs or other forms of searching), in addition to more complex concepts regarding consent, control and accountability of personal data about travellers collected through these infrastructures. Privacy issues in the transportation domain are thus different because they conflate privacy as it relates to personal space (physicality) and privacy as it relates to control of personal data about oneself.

POLICY RECOMMENDATIONS

The empirical evidence from this study contributes to some interesting insights which can inform policy.

- The study highlights that acceptability of surveillance and security measures depends on the level of access to personal information. Thus the regulations/infrastructure designed around security and privacy need to address the concerns relating to certain forms of surveillance and measures.
- While the level of similarity of preferences observed across the EU27 is noteworthy, there are interesting differences. For example, in countries that have experienced terrorism on transport facilities in recent past, respondents indicate stronger preferences for metal detectors, unlike other countries in EU27. Further, certain groups of respondents have different preferences than others. The security and surveillance infrastructure needs to take into account the needs of various segments of society.
- From a regulatory perspective, the issues most at stake concern creating a culture of accountability, particularly where public and private organisations are involved in the collection and use of these data. Whilst private sector organisations may collect such data in order to deliver efficiencies in network management, the same data might be useful and could be disclosed to government bodies in the interests of law enforcement or national security. Further challenges exist in communicating these terms and conditions of data to the users of transportation facilities.

STRENGTHS AND LIMITATIONS

This study is first ever to provide an evidence on citizen's security and privacy preferences across the EU27 using a stated preference survey. The strength of this study lies in the rich insights it provides on public preferences towards type of surveillance, data privacy settings, security personnel, and security checks. Limitations of this study include possible sources of error due to survey nonresponse, question wording and question order. While this research presents an aggregate picture for EU27, it does not estimate country specific models which could provide even greater insight into variations across the 27 Member States. Further, this study is subject to the limitations of a stated preference survey. Actual real-life preferences may be different and the concerns could change with time. Nevertheless, the findings presented here are useful to understand the *relative* preferences and contribute to the scarce evidence base on trends in preferences related to privacy and security.

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APPENDIX

Country codes

BE	Belgium
BG	Bulgaria
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
IE	Ireland
EL	Greece
ES	Spain
FR	France
IT	Italy
CY	Cyprus
LV	Latvia
LT	Lithuania
LU	Luxembourg
HU	Hungary
MT	Malta
NL	Netherlands
AT	Austria
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
FI	Finland
SE	Sweden
UK	United Kingdom

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